Image De-blurring using Blind De-convolution Algorithm

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Abstract - *Blurring is usually caused by defocus or relative motion, which can be formulated by the convolution of the point-spread-function (PSF) and latent image. Advanced techniques such as image enhancement, de-blurring, denoise, and super resolution have been developed to improve image quality post-digitization. De-convolution using blind method is very complex method because recovery of image is performed using less or no prior knowledge of the point spread function (PSF). In this propose method blind de-convolution technique has been implemented to de-blur a image. To add blur in the image the different blur models are used here, these are Gaussian Blur, Motion Blur, Average blur. Maximum likelihood estimation technique is utilized using our propose blind de-convolution algorithm for better results. The various parameters have been calculated such as RMSE, MSE, PSNR, SNR, SSIM and Histogram. Experimental results show that blind de-convolution method runs faster than conventional work.*

Key Words: *Blur, Image Restoration, Image degradation, Deblurring, PSF*

1. INTRODUCTION

In daily life, many images such as photographs, pictures, books, video and so on, so the image and human life are indivisible. With the fast growth in modern digital technology, using digital image as digital information carrier has been the people's attention. The digital images are used in various area, such as medical, military and transportation, microscopy imaging and photography deblurring *etc.* The recorded image consisting a noise and blur version of original picture. The analysis of various pictures using techniques that can identify shades, colours and relationships which cannot be perceived by the human eye.

Image deblurring is an inverse problem whose aspire is to recover an image which has suffered from linear degradation. The blurring degradation can be space variant or space-in variant. Image deblurring methods can be divided into two classes: Non-blind, in which the blurring operator is known and blind, in which the blurring operator is unknown. Blurring is a form of bandwidth reduction of the image due to imperfect image formation process. It can be caused by relative motion between camera and original image. Normally, an image can be degraded using low-pass filters and its noise. This low-pass filter is used to blur/smooth the image using certain functions. Image restoration is to improve the quality of the degraded image. It is the process of recovering the original scene image from a degraded or observed image using knowledge about its nature. Blind Image De-convolution is a more difficult image restoration where image recovery is performed with little or no prior knowledge of the degrading PSF.

In this paper, the new blind de-convolution algorithm is designed to restore a original image from the degraded image. The main objective of this paper is to restore a original image from degraded image. This paper is structured as follows: Section 2 describes the literature survey on restoration of an image. Section 3 describes the deblurring algorithm and overall architecture of this paper. Section 4 describes the sample results for de-blurred images using our proposed algorithm. Section 5 describes the conclusion.

2. LITERATURE REVIEW

Previous related researches have worked on the various filtering techniques to reduce noise and blur factor of image, but it has its own disadvantages and then developed various deblurring algorithms. Various work has been done on deblurring algorithms on various platform and with various assumption. Some related proposed work has been discuss below.

Satoshi Motohashi [1] worked on gradient reliability map(R-map). In this paper a novel algorithm based on two-step blind de-convolution is done. In this paper, during latent image restoration step, total variation regularization is applied to reduce texture components and noise; and shock filter is applied to emphasize the edges. The gradient reliability map is then applied to decrease the edges, which are severely affected in the PSF estimation. Fu-Wen Yang [2] proposed a algorithm on the blind deblurring method. In this blind deblurring method needing to predict a blur kernel in own way. The color distribution of edges is more distinct in clear image than in a blurred image. The filter is proposed to make edges in a blurred image clearer for use as reference image. Marapareddy. R [3] worked on Wiener filtering for blur image restoration which is degreded due to complex surrounding environment. Here first find out atmospheric turbulence degradation model. After that inverse filtering and minimum mean square error i.e., for restore the blurring image the wiener filtering is applied. Shuyin Tao [4] formulate the de-convolution problem by combining negative logarithmic poisson likelihood with total variation (TV) regularization, and describe a fast algorithm which is based on the method of Lagrange multiplier to solve it. The restored image is achieved by alternately solving two sub-problems. Rinku kalotra [6] worked on the two popular restoration techniques viz. LRA and BID are used and analyzed in the restoration of X-ray images. X-ray image play a important role in considering with the detection of several disease in a patients and they face the problem of motion blur and Gaussian noise. Satoshi Hirano [5] worked on the blind method restoration that rapidly restored blurred image using local patches. In this algorithm, a portion of blurred image is utilized for the PSF(Point Spread Function) calculation. In addition, a new technique proposed for a automatic PSF size estimation algorithm which is used for an generation of autocorrelation map. Punam patil [8] worked on the blind de-convolution technique using canny edge detector. In the blurred image edges the canny edge method is used for detection of ringing effect and then it can be removed before restoration process. Masanao Sawada [7] worked on novel blind image restoration algorithm which is depends on the total variation(TV) regularization and the shock filter. It consist of alternative iteration of the point spread function calculation and de-convolution.

3. METHODOLOGY

The image restoration techniques is used to reduce noise and recover resolution loss. Image processing techniques are performed either in the image domain or in the frequency domain. The general system design describes the blind image restoration is represented in a block diagram given below in Figure 1

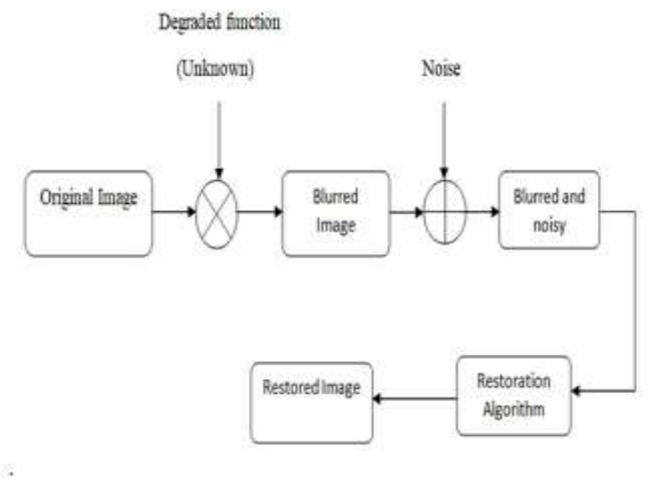

Fig -1: Block Diagram for Blind Image Restoration

3.1 Degradation Model

There are varieties of degradation models are studied that contribute to the recording of a distorted image. Although, there are non-linear degradation models, where the distortion becomes a function of the GTI itself, such as X-ray images. In this work, linear models, which are reasonable to model many distortions in photography. The simplest model takes the form of a result of two phenomena, namely degradation due to image acquisition or defects of the imaging system and distortion due to random noise. Mathematically, the model accounting for this degradation can be represented as,

$$b = k * g + n$$

Where b is the distorted image, k is a linear operator and n represents the additive random noise. In image restoration, k is mostly referred as the point spread function (PSF) or blur kernel. An ideal imaging system would have a delta function as the PSF, which however is not realistic.

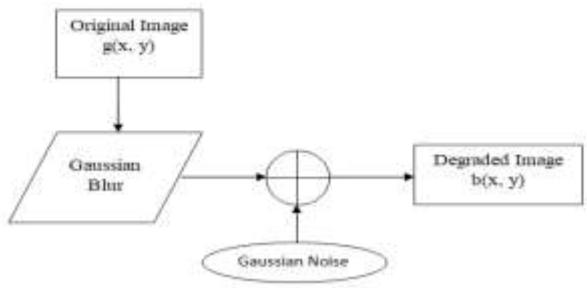

Fig -2: Degradation Model

3.2 Restoration Model

In Restoration model, the degraded image is reconstructed using restoration filters. In this process noise and blur factor is removed and get an estimate of the original image as a result of restoration. The closer the estimated image is to the original image the more efficient is our restoration filter. Figure 3 below represents the structure of restoration model.

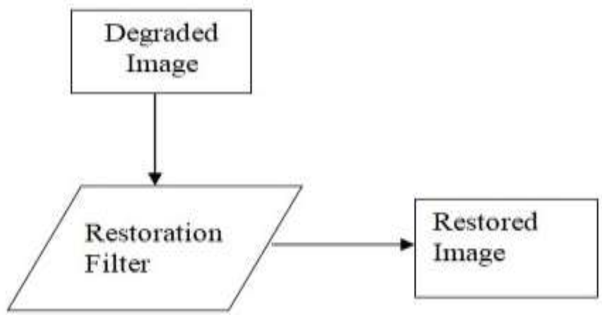

Fig -3: Restoration Model

There are numerous techniques and algorithms available for Image restoration. Each technique has its own features. In this method the new blind de-convolution technique is used. This Technique allows the reconstruction of original images from degraded images even when we have very little or no knowledge about PSF. These techniques are more difficult to implement and are more complicated as compared to other category.

3.3 Overall Architecture of Image Restoration

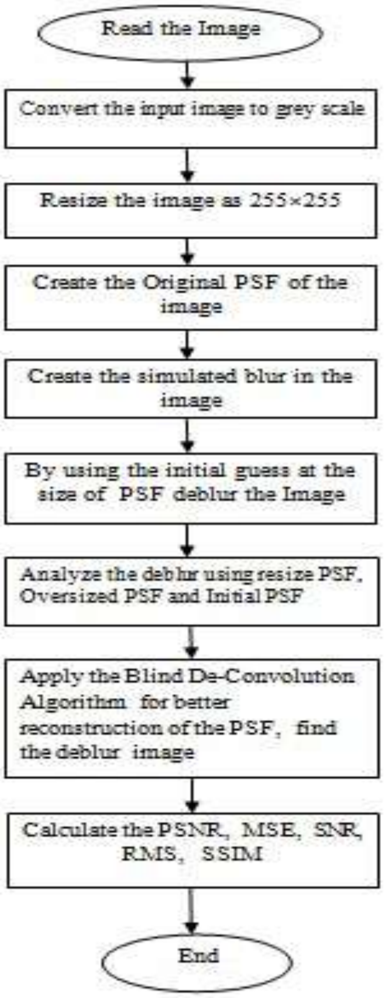

Fig -4: Overall Architecture of Image Restoration

This section presents the proposed work for Blind Image Restoration technique. In particular, this section is dividing into two sections, which deal with the addition blur and noise in image with different blur models and the next restoration of the image with blind de-convolution technique. Figure 5 shows flow chart of restoration process which describe the whole process step by step of de-blurring algorithm. In this propose algorithm the main aim is to reconstruct original image from the degraded image. First take the original image. Convert this image into gray scale image. After Converting into gray scale resize the image.

After addition of degradation function such as Gaussian blur, Average blur, Motion blur in original image blurred image is formed. After that Gaussian noise is added into the degraded image. Analyze the de-blur using undersize PSF, oversize PSF and initial PSF. Then blind de-convolution algorithm is applied for better reconstruction of the PSF and for obtaining the original image. Then calculate different parameters.

4. EXPERIMENTAL RESULTS

This provides an overall performance of the experimental models based on blind de-convolution algorithm. In this blind de-convolution is performed on three different models. The experiment is performed on standard dataset of MATLAB.

4.1 Gaussian Blur Model

In the Gaussian blur model for performing the operation first take the original image of size 526 by 526 as an input image. The input image is resized into 256 by 256 size. The color image consists of three planes, so the preprocessing on color image is difficult. Hence original image is converted into gray scale. In the gray scale image the Gaussian blur is added in the image. The Gaussian blur creates degradation in the image. After addition of blur some parts of information of image is lost in processing of image. After preprocessing the image obtain is blur image. After addition of blur the Gaussian noise is added in the image. This Gaussian noise creates unwanted variation of brightness. The Gaussian noise creates disturbance in the image. On the blur and noise image the blind de-convolution algorithm is performed with PSF. Thus de-blur the image to obtain the original image.

Fig -5: Blur Image

Fig -6: Deblur with PSF

4.2 Motion Blur Model

In the original gray scale image the motion blur is added in the image. The motion blur creates degradation in the image. After addition of blur some parts of information of image is lost in processing of image. The Gaussian noise is added in the image. This Gaussian noise creates unwanted variation of brightness and also creates disturbance in the image. On the blur and noise image the blind de-convolution algorithm is performed with PSF. Thus de-blur the image to obtain the original image.

Fig -7: Motion Blur Image

Fig -8: Deblur with PSF

4.3 Average Blur Model

In the original gray scale image the average blur is added in the image. The Gaussian blur creates degradation in the image. After addition of blur some parts of information of image is lost in processing of image. On the blur and noise image the blind de-convolution algorithm is performed with PSF. Thus de-blur the image to obtain the original image.

Fig -9: Average Blur Image

Fig -10: Deblur with PSF

We used images to experimentally validate the proposed method. Table I shows the experimental parameters. The above figure shows the experimental results of a blurred image and the results of the proposed method, respectively. Table shows the computation time of the proposed method for the experimental images. The results show that it is possible to obtain sharp images because the correct PSF can be estimated. Moreover, the reconstructed images of the proposed method are clearer than those of the conventional method.

Table -1: Gaussian Blur Model

Parameters	Conventional Method (Lucy-Richardson)	Proposed Method (Blind De-convolution)
MSE	32.6753	33.4153
RMSE	2.40759	2.40429
PSNR	31.5413	32.8913
Correlation	0.96853	0.97854
SNR	8.4429	8.4429
SSIM	0.7283	0.7269

Table -2: Motion Blur Model

Parameters	Conventional Method (Lucy-Richardson)	Proposed Method (Blind De-convolution)
MSE	43.8702	42.4202
RMSE	2.5920	2.5520
PSNR	29.4321	31.8551
Correlation	0.9297	0.9697
SNR	7.0204	7.5204
SSIM	0.6448	0.6478

Table -3: Average Blur Model

Parameters	Conventional Method (Lucy-Richardson)	Proposed Method (Blind De-convolution)
MSE	42.8752	40.3342
RMSE	2.5178	2.5207
PSNR	28.5931	29.6532
Correlation	0.9512	0.9513
SNR	7.3665	7.3617
SSIM	0.6945	0.6961

The results gives in table above for the three different blur models. The result shows that the different models give the different parameters. In the above table the Gaussian blur model shows the best PSNR value with less MSE value. In this system the blind de-convolution algorithm is performed on different image for finding the parameters. This output parameters is compared with the conventional method i.e Lucy-Richardson.

Table -4: Processing Time

Image Size	Conventional Method (Second)	Proposed Method (Second)
482 × 482	12.31	9.02
1920 × 1080	13.05	10.11
753 × 502	12.16	9.19
1024 × 683	13.21	11.01

The timing comparison table shows that how much timing is required to run the images. This method runs faster than the conventional method.

5. CONCLUSION

This present study demonstrated the various restoration techniques that have been developed to restore the original image from the degraded image. The proposed schemes along with a number of restored schemes are simulated on standard and naturally blurred images under different parametric PSFs. Here mainly three techniques have been simulated and compared. The results show the performance by the gaussian blur, motion blur and average blur. This algorithm have different results and the performance of these algorithm is measured in terms of parameter like PSNR (Peak Signal to Noise Ratio), MSE (Mean Square Error), SNR (Signal to Noise Ratio), RMSE (Root Mean Square Error), SSIM and Histogram. Higher the value of PSNR shows the more clear image quality. Experimental results demonstrate that our method runs an order of magnitude faster than previous work, while the deblurring quality is comparable. GPU implementation makes method fast enough for experimental use.

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